# New Catalyst Enables Fuel Cells to Run on Ordinary Liquid Fuels

ARGONNE NATIONAL LABORATORY

## Challenge

Fuel cell technology promises to deliver vehicles that will produce no harmful emissions. However, the fuel cells currently under development for use in fuel-cell-powered vehicles require high-quality hydrogen gas to operate. The lack of an infrastructure to deliver hydrogen to drivers means that the first fuel-cell vehicles will have to produce their own hydrogen gas "on the run." The fuel cells will require onboard fuel processors that chemically convert, or "reform," hydrogen gas from liquid hydrocarbons, such as gasoline, liquefied natural gas, methanol, and ethanol. Finding the right catalyst (a substance that facilitates the chemical reforming reaction) to reform a variety of liquid fuels into hydrogen in a compact, fast-starting, and efficient fuel processor has presented an enormous challenge.

## Argonne Solution

Argonne researchers have developed and patented a new class of catalytic materials consisting of Class VIII (iron group) metals applied to a substrate that conducts oxide ions (Figure 1). During the last three years, the catalyst formulations were refined and various supporting structures were tested to maximize the exposed surface area. These efforts led to the development of a microchannel structure that improves catalytic activity by a factor of 25,which means a fuel processor can be smaller and less expensive because it needs 25 times less catalytic material (Figure 2). The Argonne design removes the rate-limiting factor observed in other designs to allow mass transport to occur almost as fast as the catalyzed reforming reaction itself.

*Figure 1. New catalyst could help bring environmentally friendly vehicles to the marketplace.*

*Figure 2. Monolithic structure of Argonne's autothermal catalysts, showing microchannels.*

## How Does the Technology Work?

The Argonne autothermal reforming catalyst is used in the first stage of the reformer where fuel, air, and water are converted into a hydrogen-rich gas. This gas needs to be further purified in a shift and preferential oxidation stage, as shown schematically in Figure 3, before it can be used in a fuel cell. All three stages, plus additional heat exchangers, are integrated into the reactor shown in Figure 1.

Unlike most conventional catalysts that are degraded by sulfur, the Argonne autothermal reforming catalyst tolerates the sulfur found in many petroleum-based fuels.

## Accomplishments

The Argonne catalyst has demonstrated the ability to efficiently reform a variety of ordinary liquid fuels into hydrogen. This "fuel-flexible" capability makes the catalyst compatible with a wide range of technologies.

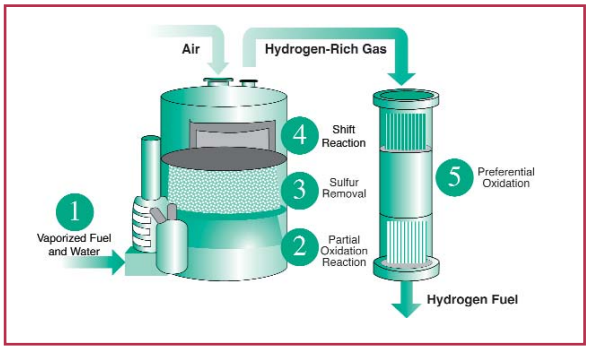


*Figure 3. Diagram of fuel cell reformer.*

Süd-Chemie, Inc., a leading supplier of catalysts, has been licensed to manufacture and distribute the Argonne catalyst for commercial use (Figure 4).

The Argonne catalyst was named one of the top 100 technological innovations in 2000 by *R&D Magazine* in its R&D 100 Awards.

## Impact

The autothermal reforming catalyst will help make fuel-cell-powered vehicles more consumer-friendly by enabling them to run on ordinary liquid fuels. Depending on the commercial success of these vehicles and of other applications for fuel cells, the worldwide market for such a catalyst could be as high as half a billion dollars per year within 10 years.

The Argonne catalyst will also be used in fuel-cell systems designed for stationary applications, such as power sources for homes and businesses. Power shortages in the electric utility grid can be mitigated by individually owned fuel-cell generators providing electrical power to homes and commercial buildings. The fuels of choice for these applications are natural gas and propane.

The ability of the catalyst to work with a variety of fuels, including renewable fuels, can enhance energy security by helping reduce the need for imported fossil fuels.

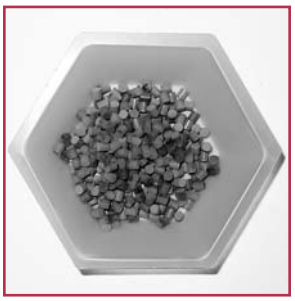

*Figure 4. Catalyst pellets made by Süd-Chemie.*

## Partners

DaimlerChrysler
dmc2
ExxonMobil Corporation
General Motors Corporation
Hydrogen Burner Technology
Los Alamos National Laboratory
Nuvera Fuel Cells
Pacific Northwest National Laboratory
University of Alabama
University of Puerto Rico

## Contact

Michael Krumpelt
Chemical Technology Division
Phone: 630/252-8520
Fax: 630/252-4176
E-mail: krumpelt@cmt.anl.gov

Argonne National Laboratory is operated by The University of Chicago for The U.S. Department of Energy.